DOES VIRTUAL REALITY ELICIT PHYSIOLOGICAL AROUSAL IN SOCIAL ANXIETY DISORDER

by

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ABSTRACT

The present study examined the ability of a Virtual Reality (VR) public speaking task to elicit physiological arousal in adults with SAD (n=25) and Controls (n=25). A behavioral assessment paradigm was employed to address three study objectives: (a) to determine whether the VR task can elicit significant increases in physiological response over baseline resting conditions (b) to determine if individuals with SAD have a greater increase from baseline levels of physiological and self-reported arousal during the in vivo speech task as opposed to the VR speech task and (c) to determine whether individuals with SAD experience greater changes in physiological and self-reported arousal during each speech task compared to controls. Results demonstrated that the VR task was able to elicit significant increases in heart rate, skin conductance, and respiratory sinus arrhythmia, but did not elicit as much physiological or self-reported arousal as the in vivo speech task. In addition, no differences were found between groups. Clinical implications of these findings are discussed.

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CHAPTER ONE: INTRODUCTION

Social Anxiety Disorder (SAD; also known as Social Phobia) is defined as a "marked and persistent fear of one or more social situations in which the individual is exposed to possible scrutiny by others (APA, 2013). With a 12-month prevalence rate of 6.8%, SAD is ranked as the second most prevalent psychiatric disorder (Kessler, Chiu, Demler, & Walters, 2005). The age of onset for SAD ranges from 15.7 to 20.0 years (Amies, Gelder, & Shaw, 1983; Liebowitz, Gorman, Fyer, & Klein, 1985; Marks & Gelder, 1966; Turner, Beidel, Dancu, & Keys, 1986) although children as young as 8 years of age have been diagnosed with this disorder (Beidel, Turner, & Morris, 1999). Commonly avoided situations include attending parties, eating in front of others, meeting new people, using public restrooms, and speaking up in class or at meetings. Among these situations, the most prevalent is public speaking (Mannuzza et al., 1995; Stein, Walker, & Forde, 1996).

When individuals with SAD encounter social or performance situations, they often experience negative cognitions such as "If I say the wrong thing, nobody will like me" or "People are yawning, they must think I'm boring." These cognitions are typically accompanied by physiological symptoms such as increased heart rate, sweating, blushing, trembling hands and voice, or hot flashes. These physiological symptoms, known as the "fight or flight response," are considered part of a primitive, inborn response that prepares the body to respond to a perceived attack, harm, or threat to survival. This reaction can sometimes be invaluable, such as in combat situations or during prehistoric times when predatory animals were a real danger. However, when this reaction occurs in situations that are not physically dangerous, a maladaptive pattern of fear and avoidance may emerge. Knowledge that the fears are unreasonable and actual harm is

unlikely to occur does little to ameliorate anticipatory anxiety and physiological levels of arousal.

The distress caused by SAD, and the accompanying avoidance behavior, commonly leads to significant impairment in occupational, academic, social, and emotional functioning (Liebowitz et al., 1985; Turner et al., 1986; Wittchen & Beloch, 1996; Zhang, Ross, & Davidson, 2004). On average, individuals with SAD are 10 percent less likely to graduate college, earn 10 percent less salary, and are 14 percent less likely to hold upper-level jobs than those without SAD (Katzelnick et al., 2001). Individuals with SAD are reported to have higher levels of drug dependency, are more likely to seek health services and take prescription medication (Patel, Knapp, Henderson, & Baldwin, 2002). In addition, SAD is highly comorbid with both alcoholism and depression (Kessler, Stang, Wittchen, Stein, & Walters, 1999; Schneier, Johnson, Hornig, Liebowitz, & Weissman, 1992). Overall, the annual cost of anxiety disorders is approximately $42.3 billion, or $1,542 per individual (Greenberg et al., 1999).

Despite the clear burden SAD places on the individual and the economy, many adults in the United States are not receiving treatment. For example, the Epidemiological Catchment Area study reported that over two-thirds (72%) of community respondents with SAD had never received outpatient mental health treatment (Robins & Regier, 1991). People least likely to seek treatment tend to be younger, less educated, and are less likely to be white than those who do receive treatment. Researchers have identified multiple barriers to treatment reported by those with SAD including an inability to afford treatment, uncertainty about where to go for help, fear of being stigmatized, social isolation, and suicidal ideation. Ironically, the symptoms of SAD themselves prevent these individuals from seeking help (Olfson et al., 2000). Unfortunately,

SAD tends to be underdiagnosed, with general practitioners assigning diagnosis of an anxiety disorder in only 24.2% of actual cases (Weiller, Bisserbe, Boyer, Lepine, & Lecrubier, 1996).

Current Treatments

Pharmacological Treatments

A meta-analysis examining the therapeutic efficacy of pharmacological interventions for the treatment of SAD reported an average treatment effect size of .62. More specifically, selective serotonin reuptake inhibitors (SSRIs) had the strongest outcomes and lowest dropout rates. The SSRI fluvoxamine had an effect size of 2.73 and a dropout rate of 3% (Gould, Buckminster, Pollack, Otto, & Yap, 1997; van Vliet, den Boer, & Westenberg, 1994) while sertraline had a similarly strong effect size of 1.05 and a dropout rate of 0% (Gould et al., 1997; Katzelnick et al., 1995). Monoamine oxidase inhibitors (MAOIs) phenelzine and moclobemide yielded large mean effect sizes of .64 with a dropout rate of 13.8%, although their use and acceptability is limited by dietary restrictions. Benzodiazepines such as alprazolam and clonazepam demonstrated a mean effect size of .72 and a dropout rate of 12.0%; however, there are concerns about their use in patients with alcohol abuse. While effective for individuals with performance anxiety, beta blockers do not appear useful for treating pervasive SAD and were found to be less effective than placebo in some studies (Gould et al., 1997).

While some individuals prefer pharmacological treatments over psychotherapy, many are deterred by side-effects and withdrawal problems. In addition, pregnant women are discouraged from pharmacological interventions due to unknown teratogenic effects (Gould et al., 1997). In addition, research on benzodiazepines for panic disorder has shown that relapse is common after

successful discontinuation and this may also be true for SAD (Fyer et al., 1987; Gould et al., 1997; Marks et al., 1993).

Cognitive-Behavioral Therapy

Currently, cognitive-behavioral therapy (CBT) is considered the gold-standard treatment for SAD. CBT paradigms include exposure to social stimuli (EXP), homework assignments, cognitive therapy (CT), a combination of CT and EXP, and social skills training (SST). Although SST has an EXP component, the two forms are considered separate as the main goal of SST is to teach interpersonal skills whereas the goal of EXP is to have the participant contact the feared stimulus in order for extinction to occur (Taylor, 1996). A meta-analysis by Taylor (1996) examined the efficacy of six different treatment conditions using the results of 42 treatment-outcome studies. Specifically Taylor's meta-analysis compared wait-list control, placebo, EXP, CT, a combination of CT and EXP, and SST. All of the conditions had larger effect sizes than the wait-list control and did not differ in drop-out rates. However, only the combination of CT and EXP had a significantly larger effect size than placebo and supported the use of CBT for SAD. In addition, meta-analysis results revealed that the average effect size for CBT was .74. This was not, however, significantly higher than the effect size for pharmacotherapy or the effect size of .49 for combination treatments (Gould et al., 1997). In terms of drop-out rate, cognitive-behavioral therapies, pharmacotherapies, and combination treatments were not significantly different (Gould et al., 1997).

While CT is useful for addressing the individual's cognitive distortions during social situations, EXP is especially useful for addressing fearful responses and learned avoidance

behaviors that are thought to maintain and contribute to SAD. With an effect size of .89, EXP seems to produce a more favorable outcome than studies using cognitive methods alone (ES=.60) (Gould et al., 1997). With an extensive body of research demonstrating its efficacy, exposure therapy leads to the creation of new memory structures that replace the maladaptive ones (Foa & Kozak, 1986; Gould et al., 1997). EXP has shown long-term improvements in disorders such as agoraphobia and obsessive-compulsive where relaxation therapy and lengthy discussions about symptoms showed little effect (Chambless, Foa, Groves, & Goldstein, 1979; Emmelkamp & Kuipers, 1979; Foa et al., 1983; Marks, Hodgson, & Rachman, 1975).

There are two main variations of EXP: in vivo exposure and in vitro exposure. Confronting a feared stimulus directly is known as in vivo exposure (Latin for "in life"). If the stimulus is imagined, it is considered in vitro exposure (Latin for "in glass"). EXP often involves the use of a fear hierarchy where individuals begin with exposure to moderately stressful situations and, as they become less anxious and more confident, work towards situations that are most stressful. Graduated exposure with a spider phobia may begin with imagining the spider, and then looking at a picture of a spider, then viewing an actual spider from a distance, and eventually holding a spider with no physiological or cognitive distress.

Although there is extensive support for in vivo exposure therapy, it is not always practical or ethical, especially when the stimuli are actually dangerous. Certain scenarios may be difficult to recreate or repeat and, particularly in the case of flight phobia, can be prohibitively expensive. Another disadvantage of in vivo exposure therapy is that the individual's fear may be so overwhelming that they are unwilling to enter therapy. While some may argue that imaginal exposure may be the most appropriate solution, data indicate in vivo exposure is superior to

imaginal exposure, especially for treating specific phobias (Foa & Kozak, 1986). Furthermore, in order for imaginal exposure to be effective, the individual must have good cognitive skills to allow complete immersion in the feared situation. In addition, the individual must be able to feel present in the scenario through imagination alone and not avoid contact with the stimulus by cognitive distraction.

Virtual Reality Exposure Therapy

In an effort to address the limitations of in vivo and in vitro exposure, virtual reality exposure therapy (VRET), has been developed as a viable alternative. VR incorporates computer graphics with different display and sensory technologies to allow the individual to feel immersed in the virtual environment (Krijn, Emmelkamp, Olafsson, & Biemond, 2004; Rothbaum & Hodges, 1999). While there are many versions of hardware and software that can be used to facilitate VR, the most common approach involves a head mounted display (HMD). The HMD consists of a visor with separate display screens for each eye. The visor allows the sight of the individual to be focused on the computer-generated images on the display screens, blocking perception of the surrounding environment. The HMD has a built in electromagnetic tracking system that matches changes in head movements. For example, if the patient moves their head to the left, the left side of the environment is displayed. The therapist is not only able to view what the patient sees, but is able to move the patient through the environment (Krijn et al., 2004; Rothbaum & Hodges, 1999). Auditory stimuli presented via headphones can enhance immersion. Speakers emitting low-frequency sound waves can be built into a platform underneath a chair, and can simulate sensory cues, such as the vibrations felt as a plane takes off.

Olfactory cues can also enhance stimulus presentation via controlled release of scented air to further immerse the patient in the environment.

To be consistent with emotional processing theory (Foa & Kozak , 1986), VRET must meet three conditions. The patient must feel immersed in the environment as opposed to a passive observer (Slater, Pertaub, & Steed, 1999). The virtual environment must be generalizable to real-life situations so that when extinction occurs in the virtual environment, the patient experiences a decrease in distress and avoidance in the corresponding real-life situation. Finally, the virtual environment must elicit physiological arousal which would indicated that the core elements of the fear are being addressed (Hodges et al., 1994; M. M. North, North, & Coble, 1998; Regenbrecht, Schubert, & Friedman, 1998; Schuemie et al., 2000).

Since 1992, there has been increasing interest in the application of VR to treat anxiety disorders (M.M. North, North, & Coble, 1996a, 1996b, 1996c). One meta-analysis (Powers, 2008) reported a large mean effect size (1.11) for VRET in comparison to control conditions. The majority of studies have focused on VR as a treatment for specific phobias including spider phobia, fear of driving, claustrophobia, acrophobia, and flight phobia. The field is currently expanding to include disorders such as posttraumatic stress disorder and agoraphobia (Krijn et al., 2004). The most challenging types of phobias for VR to address are ones including other people, such as SAD. Currently, VRET for treating SAD is utilized for fear of public speaking and includes a virtual conference room and virtual auditorium environments (Botella et al., 2000; J. M. Lee et al., 2002).

Although the ability of VR as a tool to increase the efficacy of exposure therapy appears promising (Anderson, 2005; Anderson, Rothbaum, & Hodges , 2003; Harris, Kemmerling, &

North, 2002; Klinger et al., 2005; M. North, North, & Coble, 1997; Wiederhold & Wiederhold, 1998) , questions about the ability of VRET to satisfy Foa and Kozak's (1986) basic requirements remain. Furthermore, most outcome data are based on self-report of decreased emotional distress among analogue populations, limiting the applicability of the data to clinical samples of patients with SAD. In particular, little research to date has addressed the extent to which participants feel present or engaged with the virtual environment and while interacting with the virtual stimuli (K. M. Lee, 2004; Schubert, Friedmann, & Regenbrecht, 2001).

Although data are sparse, researchers have attempted to examine presence in different ways. Slater et al (2006) compared confident or phobic speakers when talking to an empty VR auditorium or the same virtual auditorium, with a neutral VR audience. Confident Speakers showed no significant differences in anxiety across conditions. When facing the virtual audience, Phobic Speakers had higher self-reported anxiety, doubled self-report somatic response, and significant increases in heart rate from the Confident Speakers. In addition, the Phobic Speakers showed significant decreases in heart rate when speaking to the empty room compared to Phobic Speakers speaking to an audience (Slater, Pertaub, Barker, & Clark, 2006). Although these results did not use a clinical sample or an in vivo control, the Phobic Speaker's increase in arousal with the VR audience provides some data that participants were able to feel immersed in the virtual environment. This study replicated and expanded upon previous findings (Pertaub, Slater, & Barker, 2002) in which participants gave a speech to a neutral, positive, or a negative virtual audience. In this study, all three virtual environments elicited anxiety in those with elevated public speaking fears, yet regardless of their level of fear, all participants reported feeling anxious when giving a speech to the negative audience.

In addition to presence, researchers have examined the ability of VR to elicit physiological arousal. A study by Kotlyar et al (2008) compared self-report and physiological measures of anxiety in healthy controls during a VR speech task and during an in vivo math task. Participants demonstrated a significant increase in diastolic blood pressure, systolic blood pressure, and heart rate, indicating that the VR task elicited significant physiological arousal. There were no significant increases in cortisol for either of the two tasks and scores on the State Trait Anxiety Inventory state subscale did not reflect significantly increased subjective distress. This study, while promising, was limited by a small sample size, the lack of a clinical population, and the lack of a comparable control as the VR condition was not compared to an in vivo speech task.

The Current Study

Although research into VR treatments for SAD is still in its infancy, the results so far are promising. VRET has the potential to become a cost-effective, practical, and efficacious treatment for SAD. Based on research by Garcia-Palacios (2007), with 76% of participants choosing VRET over in vivo exposure, VRET may appeal to the significant portion of individuals with SAD who may be hesitant to seek in vivo exposure. Given the high prevalence of SAD, low rates of treatment seeking, and difficulty in constructing appropriate in vivo exposure conditions for people with SAD (e.g., difficulty finding audience members), the development of VR has the potential to alleviate the burden this disorder places on the individual, clinicians, and the economy.

However, studies to date of VR's potential efficacy are limited by reliance on self-report measures of anxiety, small sample sizes, lack of a clinical population, and lack of objective data using a comparable comparison group. Furthermore, our understanding of VR's ability to mimic social fear cues that elicit emotional distress (as indicated by increases of physiological arousal), which is necessary for extinction to occur, is lacking. These limitations warrant additional research and therefore, this study will extend previous research in two ways. First, in order to examine VR's ability to elicit physiological arousal similar to in vivo exposure, this study compared physiological responses elicited by a VR public speaking environment and a comparable in vivo speech task in individuals with SAD and healthy controls. This allowed a direct comparison of the physiological arousal elicited in VR and an in vivo speech task. Second, this study built upon the physiological response data from previous studies by including measurements of skin conductance, respiration, and heart rate measured continuously before, during, and after each of the two tasks. In order to replicate previous research, objective physiological data was compared to self-report measures of anxiety as well as a measure of presence.

This study had the following hypotheses:

1. When placed in a virtual environment and asked to give a speech, all participants will experience significantly increased physiological response over baseline resting conditions.
2. Individuals with SAD will have a greater increase from baseline levels of physiological and self-reported arousal during the in vivo speech task as opposed to the VR speech task.

3. Individuals with SAD will experience greater changes in physiological and self-reported arousal during each of the speech tasks in comparison to healthy controls.

CHAPTER TWO: METHODOLOGY

Participants

Fifty-nine adults were recruited via community advertisement and UCF's undergraduate research pool. Of these, 9 participants were deemed ineligible and removed from the sample following the assessment. The final sample consisted of 50 adults representing two groups: 25 adults with SAD (12 males; 13 females) and 25 adults without any psychiatric disorder (12 males, 13 females). Adults ranged in age from 18 to 32 years (*Ms* = 21.28 and 19.48 years old respectively). Ethnicity varied within groups and included 26 Caucasians, 7 African Americans, 10 Hispanics, 5 Asian American/Pacific Islanders, and 2 who identified as belonging to the Other category (e.g., of mixed ethnic background). Demographic characteristics, comorbid diagnoses, and mean assessment scores for the sample are shown in Table 1. The most common comorbid diagnoses were major depressive disorder and generalized anxiety disorder.

To be included in the study, participants met diagnostic criteria for a) SAD or b) no current psychiatric diagnosis. Participants in the SAD group with comorbid Axis I disorders (e.g., depression) were included in the study if the diagnoses are secondary to their primary anxiety disorder. A lifetime diagnosis of current bipolar disorder, suicidal ideation, current alcohol or substance abuse, or psychosis was exclusionary. A Clinical Severity Rating (CSR) of 4 or higher was required for inclusion in the study as a participant with SAD. Because participants were asked to give a speech in front of 5 audience members, participants with SAD were included only if they endorsed frequently experiencing anxiety when speaking in front of at least 5 people. Similarly, healthy controls were only included if they denied frequent anxiety when speaking in front of at least 5 people. Exclusion criteria included any unstable or serious

medical conditions or taking any medications that, in the opinion of the researcher, might have interfered with the measures being assessed (e.g. psychoactive medications, anti-hypertensives).

Table 1 Demographic and Assessment Data for Participants

	SAD (n=25)	**Controls (n=25)**
Age M(SD)	21.28(3.09)	19.48(1.71)
Gender		
Males	12	12
Females	13	13
Race/Ethnicity		
Caucasian	12	14
African American/Black	3	4
Hispanic/Latino	8	2
Asian/Pacific Islander	2	3
Other		2
Assessment Measures M(SD)		
ADIS SAD Clinical Severity Rating (CSR)	5.64(1.19)	---
SPAI Difference Score	97.66(29.18)	25.52(16.56)
LSAS Total Score	73.44(22.07)	27.60(13.90)
HAMD Total Score	13.80(7.09)	4.76(4.20)
Comorbidity (N)		
MDD	4	---
Depressive Disorder NOS	1	---
GAD	2	---
Panic Disorder	1	---
Bipolar Disorder	1	---
Provisional OCD	1	---

Diagnostic Measures

Diagnostic Interview

To determine participation eligibility and diagnostic status, participants were interviewed using the *Anxiety Disorders Interview Schedule for the DSM-IV* (*ADIS-IV*; Brown, 1994). The diagnostic interview was conducted by a doctoral candidate in clinical psychology. As part of the ADIS-IV diagnostic interview, a CSR was assigned to each diagnosis, using a 9-point scale (0-8) where higher numbers were indicative of greater perceived distress. A CSR of at least 4 was required for inclusion in the SAD group. The ADIS-IV has demonstrated good to excellent inter-rater reliability with kappa coefficients ranging from .67 to .86 (Brown, Di Nardo, Lehman, & Campbell, 2001). To calculate inter-rater reliability, twenty-percent of the interviews were scored by a second blinded evaluator (e.g., a doctoral student within the clinical psychology program). For the diagnosis of SAD, the kappa coefficient was k=1.00. Inter-rater agreement for the CSR intraclass correlation coefficient was ICC(2,2)=.970 and the reliability was r=.967.

As part of the assessment battery, participants were administered the *The Liebowitz Social Anxiety Scale* (LSAS; (Liebowitz, 1987), a clinician rating scale to quantify the degree of fear and frequency of avoidance behavior across different social situations. The LSAS has demonstrated strong convergent and discriminate validity (Heimberg et al., 1999). To calculate inter-rater reliability and agreement, twenty-percent of the interviews were scored by a second blinded evaluator, inter-rater agreement for the LSAS was ICC(2,2)=.999 and reliability r=.998. To assess potential depressive symptoms and rule out participants who may be suffering from significant depression, participants were administered the *Hamilton Rating Scale for Depression* (HAM-D; Hamilton, 1960). With mean scores ranging from 0-27 and with depressive symptoms

presenting as secondary to SAD, no participants were excluded from the current study based on their HAM-D scores.

Self-Report Measures

To assess the range and severity of social fears, participants completed the *Social Phobia and Anxiety Inventory* (SPAI; Turner, Beidel, Dancu, & Stanley, 1989). The SPAI has high test-retest reliability of .86 and differentiates patients with social phobia from normal controls or from patients with other anxiety disorders (Turner et al., 1989). In addition, the SPAI has good concurrent and external validity (Beidel, Borden, Turner, & Jacob, 1989; Turner et al., 1989). Participants with social phobia must report a score of at least a four on item five of the Social Phobia and Anxiety Inventory, indicating the participant frequently experiences anxiety when making a speech in front of an audience. Similarly, healthy controls must report a score of less than four on this same item.

Outcome Measures

Participants completed the following battery of self-report measures:

The *Self-Statements During Public Speaking (SSPS; Hofmann & DiBartolo, 2000)* is a 10-item questionnaire designed to assess fearful thoughts experienced during public speaking. The SSPS consists of two 5-item subscales, the "Positive Self-Statements" (SSPS-P) and the "Negative Self-Statements" subscale (SSPS-N).

The *Subjective Units of Distress Scale* (SUDS) asks the participant to rate their own level of anxiety using a 9-point likert type rating scale (0 to 8; no distress to extreme distress).

Two *Visual Analogue Scales (VAS)* were included after each speech task to assess the degree to which the participant felt engaged/involved with the speech task environment and separately how strong was their sense of "being there." Participants asked to indicate their response by drawing a vertical mark on a 100mm line which was anchored by labels representing the extremes of the continuum (e.g., Not Engaged/Involved At All to Completely Engaged /Involved and Completely Detached/No Sense of Being There to Complete Sense of "Being There").

Behavioral Assessment

The assessment consisted of participation in two impromptu speech tasks (one in vivo and one virtual reality based (see procedure section below.) During the tasks, heart rate, skin conductance, and respiration were continuously monitored and recorded using the wireless MindWare Psychophysiological Ambulatory system. Continuous recording allowed assessment of physiological arousal over time and in relation to the two speech tasks. MindWare Version 3.0 allows the conversion of physiological data into meaningful statistical data to be analyzed using Mindware analysis software version 3.0.9. EKG were assessed at 30 second intervals and converted to heart rate, a measure of sympathetic and parasympathetic responses to external stimuli. RSA, a measure of vagal cardiac control related to respiration (Berntson, Quigley, & Lozano, 2007), offered a direct examination of parasympathetic activity within the Autonomic Nervous System (ANS). Finally, electrodermal activity, as measured by skin conductance level (SCL) or response (SCR) provided a measure of sympathetic activity on the ANS.

Procedure

The two speech tasks consisted of an impromptu speech in front of a live 5 person audience and a VR 5 person audience.

Prior to beginning the speech tasks, two electrodes were placed on the palm of the participant's non-dominant hand and three electrodes were placed directly on the participant's torso (one on the participant's collar bone and the other two directly below the participant's rib cage - one on each side). The electrodes were connected to the ambulatory recording device each participant wore on his/her back. Finally, a respiration belt was secured around the participant's chest. During a 10 minute adaptation/baseline period, participants sat quietly while physiological state was assessed. At the end of the baseline period, participants provided their first SUDS rating.

The order of task administration was counterbalanced to control for order effects (e.g., a random number generator determined the order of task administration), and no significant order effects were found. A 5-minute interval separated the 2 tasks to allow the participant's physiological response to return to approximately baseline levels. An overview of the procedure and the task specifics is presented below.

Speech Task 1: Virtual Reality Task

This task utilized the conference room scene from Virtually Better's software package. In this virtual environment, the participant began in a virtual waiting room, viewed through the HMD. The researcher used a game controller to lead the participant into a virtual conference room, in which a five person audience is seated around a conference table. As illustrated in

Figure 1, the audience members consisted of two men and three females of varying ethnicities (3 Caucasian, 1 African American, and 1 Asian) wearing business attire.

Participants were instructed to prepare and deliver a 10 minute speech. Participants were instructed they could choose three of five topics: What are the qualities of a good United States President? Should all states adopt mandatory no smoking in public places laws? Should corporal punishment be allowed in schools? What should be the legal drinking age and/or penalties for drunk driving? Should animals be used for scientific experimentation? (Beidel, Turner, Jacob, & Cooley, 1989). The participant was given 3 minutes to prepare their speech, during which they could make notes but were not allowed to use the notes during the speech. Following the preparation period, the participant was led into the virtual conference room and given 10 minutes to complete their speech. Participants were told to expect a bell sound to occur once 3 minutes had passed and they were given a "Stop Card" to hold up if they felt too intensely distressed and wanted to end the speech once 3 minutes had elapsed. This allowed an assessment of escape/avoidance of the 10 minute speech task. Following the speech, the HMD was removed and they provided their second SUDS rating and completed the SSPS and VAS. The participants then sat quietly for 5 minutes before the next task.

Speech Task 2: In Vivo Task

For the in vivo speech task, the virtual conference room was recreated in a conference room in UCF's Psychology Building. Four to five undergraduate volunteers, instructed to wear business attire, were seated around the conference table, similar to the virtual task. Once again, the participant was instructed to prepare and deliver a speech of 10 minutes duration. The

instructions regarding speech length, number of topics to use and the opportunity to end early were the same as above. Participants were given a new list of five topics that included: Should marijuana be made legal for medical purposes? Should schools require their students to wear a school uniform? If the government found intelligent alien life, should this information be kept secret? Should you be required to wear mandatory motorcycle helmets? Should the legal system have the options to try juveniles as adults in murder cases? (Beidel, Turner, et al. 1989). Following the preparation period, the participant was led into the real-life conference room where they had 10 minutes to complete their speech. Participants were told to expect a blue light once 3 minutes had passed, signaling the end of the three minute mandatory portion of the speech, after which point they could raise the "Stop Card." Following the speech, the participant completed their third and final SUDS as well as the SSPS and VAS.

Analytical Strategy

SCRs were counted if the fluctuation exceeded .05μS. HR data were edited for artifact following data collection. The mean change score of each channel during the first 3 minutes of each speech task was calculated and used as the overall task mean change. The mean of the final 60 seconds of the initial baseline period was used in the calculation of change scores.

One-tailed, paired samples t-tests were used to examine whether there were significant increases in physiological arousal from baseline to the VR speech tasks (Hypothesis 1). A series of 2x2 Mixed Subjects Repeated Measures ANOVAs with planned comparisons of simple effects were used to analyze physiological arousal (e.g., HR, RSA, EDA, SCR), self-reported distress (e.g., SUDS), self-reported perception of task performance (e.g., SSPS), and degree of

engagement with the task environments (e.g., VAS) (Hypothesis 2 & 3). One-tailed analyses were used to test the hypothesized findings.

Missing Data

Due to equipment failure, all HR and RSA data were unable to be collected for both speech tasks for 1 control. One participant in the SAD group declined participation in the in vivo speech task, as a result, HR, RSA, EDA, and task-related self-report measures were unable to be obtained. One participant's HR data was determined to be an outlier, as the values fell above the 3rd quartile, and was removed. These participants were not included in the analysis for which their data is missing.

CHAPTER THREE: FINDINGS

Does the VR Environment Produce Feelings of Immersion?

Prior to determining whether the VR environment was able to elicit physiological arousal, VAS "Engagement" and "Being There" scores were analyzed to determine whether the VR environment was a valid manipulation. Immersion within the VR environment suggests that it shares some features with the participant's reported fear. In addition, this suggests that the reactions elicited are beyond reactions elicited by giving a speech to no audience.

VAS Ratings

VAS Engagement. There were significant main effects for task type ($F(1,45) = 14.69$, $p < .001$) and group ($F(1,45) = 4.14$, $p = .048$), but there was no significant task x group interaction($F(1,45) = .008$, $p = .930$). With respect to the main effect for task, all participants reported more engagement in the in vivo environment that the VR environment (M_{Vivo}=69.19 and M_{VR}=53.08). Across tasks, participants with SAD reported feeling less engaged with the task environment than Controls (M_{SAD}=54.44 and $M_{Controls}$=67.83). Scores for each group for each task are depicted in Table 2.

VAS "Being There". There was a significant main effect for task type ($F(1,45) = 21.47$, $p < .001$), with all participants reporting a stronger sense of "being there" during the in vivo task (M_{Vivo}=75.05 and M_{VR}=52.19). There was no main effect for group ($F(1,45) = .869$, $p = .356$) and no significant group x task interaction ($F(1,45) = .001$, $p = .978$). Mean scores for each group during each task are depicted in Table 2.

Does the VR Elicit Subjective Distress and Cognitive Distortions?

SUDS Ratings

There were significant main effects for task type ($F(1,47) = 30.39$, $p = .000$) and group ($F(1,47) = .13.01$, $p = .001$). In addition, there was a significant task*group interaction ($F(1,47) = 5.62$, $p = .022$). Whereas both groups had significantly greater increases in subjective distress during the in vivo speech (M_{SAD}=5.58 and $M_{Controls}$=3.36), than the VR speech (M_{SAD}=3.38 and $M_{Controls}$=2.48), participants with SAD had a significantly higher increase in subjective distress than Controls during in vivo ($p<.001$), but not the VR condition ($p>.05$).

SPSS Positive Subscale

There were no significant main effect for task type ($F(1,47) = .417$, $p = .521$) or group ($F(1,47) = 1.217$, $p = .276$). In addition there was no significant interaction ($F(1,47) = 1.831$, $p = .182$).

SPSS Negative Subscale

There were significant main effects for task type ($F(1,47) = 7.41$, $p = .009$) and group ($F(1,47) = 29.17$, $p < .001$). However, there was no significant interaction ($F(1,47) = .815$, $p = .371$). With respect to the main effect for task, all participants reported more negative self-statements in the in vivo environment that the VR environment (M_{Vivo}=13.42 and M_{VR}=12.04). Across tasks, participants with SAD reported more negative self-statements than Controls (M_{SAD}=14.89 and $M_{Controls}$=10.58). Scores for each group for each task are depicted in Table 2.

Table 2 Simple Effects Results for Self-Report Measures

Variable	SAD (N=25) M			Controls (N=25) M		
	In Vivo	**VR**	***p***	**In Vivo**	**VR**	***p***
SUDS (change score)	5.58[1a]	3.38	**.001**	3.36[a]	2.48	**.030**
VAS "Engagement"	62.68[3]	46.21[2]	**.010**	75.70	59.96	**.009**
VAS "Being There"	71.89[3]	49.16[2]	**.003**	78.22	55.22	**.001**
SSPS Positive Subscale	14.18[1]	14.96	.168	14.00	13.72	.616
SSPS Negative Subscale	15.79[1]	13.96	**.015**	11.04	10.12	.200

[1] One participant refused task, unable to obtain rating.

[2] Missing data for two participants as questionnaire was added later.

[3] Missing data for two participants as questionnaire was added later, one participant refused task.

[a] Means sharing superscripts are significantly different

Task Escape

Of the participants with SAD, 8% escaped before 3 minutes during the VR speech task as opposed to 36% during the in vivo task. Out of the controls, 16% escaped from both the VR and the in vivo speech tasks before 3 minutes had elapsed. Participants with SAD, on average, spoke longer during the VR speech task than the in vivo task (M_{Vivo}=2.53 minutes and M_{VR}=3.15 minutes). Similarly, Controls spoke slightly longer during the VR speech task than the in vivo task (M_{Vivo}=4.06 minutes and M_{VR}=4.17 minutes).

Physiological Arousal

Having documented that the VR condition does elicit some cognitive and subjective distress, changes in physiological response during the two conditions are examined below.

Hypothesis 1

Overall, participants had a significant increase in HR from baseline levels (M=71.95, SD=11.61) during the VR speech task (M=89.57, SD=12.66; t(47)=-14.60, p<.001). Participants also had a significant decrease in RSA from baseline levels (M=7.03, SD=1.25) during the VR speech task (M=6.42, SD=1.16; t(48)=-3.60, p<.001), meaning that they were less able to exert control over their physiological response to the task. In addition, participants had a significant increase in SCL from baseline levels (M=8.35, SD=6.51) during the VR speech task (M=14.55, SD=7.71; t(49)=-7.40, p<.001). Finally, participants had significantly more SCRs during the VR speech task (M=6.17, SD=2.64) than during baseline (M=4.18, SD=3.77; t(49)=-3.25, p=.001).

Hypotheses 2 and 3

Heart Rate. There was a significant main effect for task type ($F(1,45) = 18.31$, $p < .001$) with all participants exhibiting a greater change in HR over baseline during the in vivo task (M_{Vivo}=22.27 and M_{VR}=17.69). There was no significant main effect for group ($F(1,45) = .636$, $p = .429$) and no significant interaction ($F(1,45) = 1.59$, $p = .219$). Looking across the tasks at 30-second intervals, it appears that heart rate reactivity patterns are the same between groups (see Figures 1 & 2).

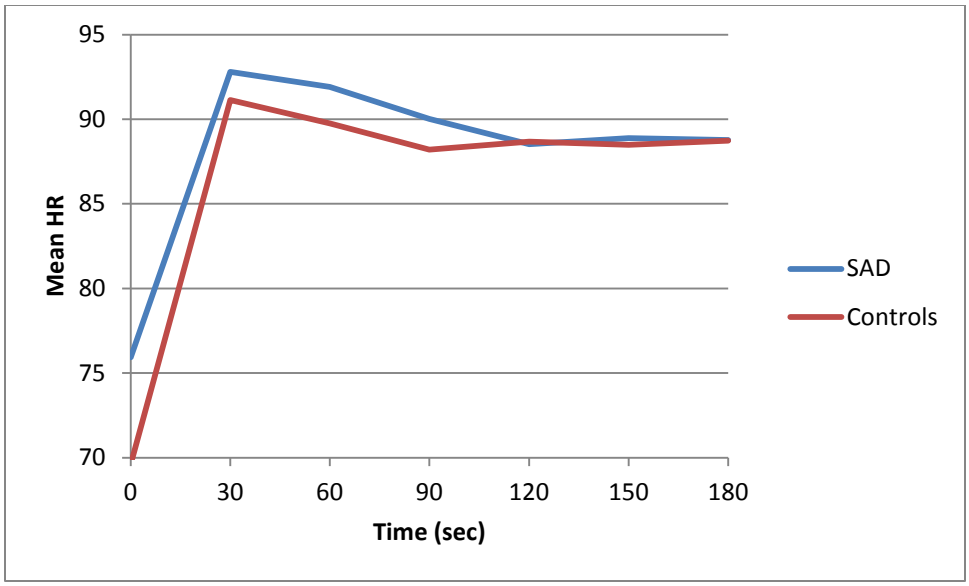

Figure 1 Changes in mean heart rate during the VR speech task

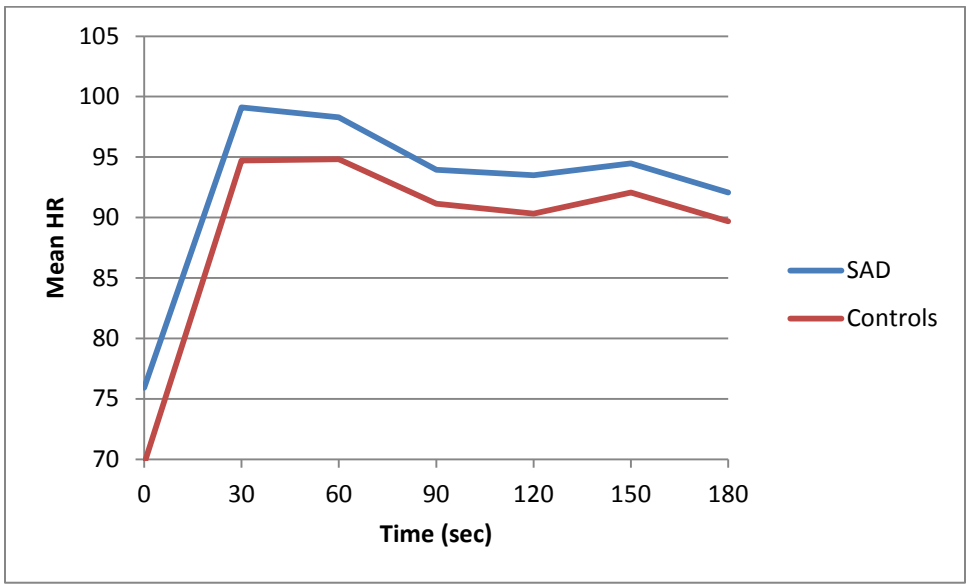

Figure 2 Changes in mean heart rate during the in vivo speech task.

Respiratory Sinus Arrhythmia. There were no significant main effects for task type ($F(1,46) = 1.78$, $p = .188$) or for group ($F(1,46) = .855$, $p = .360$). In addition there was no significant interaction ($F(1,46) = 1.907$, $p = .174$).

Skin Conductance Level. There was a significant main effect for task type ($F(1,47) = 5.546$, $p = .023$) with all participants exhibiting a greater change in SCL over baseline during the in vivo task (M_{Vivo}=6.96 and M_{VR}=6.19). There was no significant main effect for group ($F(1,47) = 1.448$, $p = .235$) and no significant interaction ($F(1,47) = .194$, $p = .789$).

Skin Conductance Response. There was a significant main effect for task type ($F(1,47) = 45.06$, $p < .001$) with all participants exhibiting more SCRs during the in vivo task (M_{Vivo}=8.50 and M_{VR}=6.15). There was no significant main effect for group ($F(1,47) = .489$, $p = .488$) and no significant interaction ($F(1,47) = .102$, $p = .751$).

Table 3 Within Groups Simple Effects Results for Physiological Measures.

Variable	SAD (N=25) M			Controls (N=25) M		
	In Vivo	**VR**	***p***	**In Vivo**	**VR**	***p***
HR	21.89[2]	15.97[3]	**<.001**	22.65 [3]	19.40[3]	**.036**
RSA	-.659[2]	-.390 [3]	**.031**	-.821[3]	-.826[3]	**.974**
SCL	5.88[1]	5.19	.076	8.05	7.18	**.067**
SCR	8.17[1]	5.93	<.001	8.83	6.37	<.001

[1] One participant refused task, unable to obtain data.

[2] One participant refused task, unable to obtain data. One participant excluded due to equipment failure.

[3] One participant excluded due to equipment failure.

CHAPTER FOUR: CONCLUSIONS

The current study sought to determine whether VR is able to elicit physiological arousal similar to in vivo exposure by comparing responses elicited by a VR public speaking environment to a comparable in vivo speech task in individuals with SAD and healthy controls. Physiological data was compared to self-report measures of anxiety as well as a measure of presence.

The first aim of the study was to determine whether the VR speech environment was able to elicit increased physiological arousal in all participants. Consistent with the findings of Slater et al (2006) and Kotlyar (2008), the VR speech produced a moderate level of immersion and elicited physiological arousal and distress. Specifically, despite feeling only partially engaged and present in the VR environment, participants still experienced significantly elevated arousal (HR, RSA, SCL) and emotional reactivity (SCRs) relative to baseline.

However, the VR environment did not appear to sufficiently address the primary concern of people with SAD – fear of negative evaluation by others. For example, following the VR speech task, a number of participants noted to the investigator, "That wasn't nearly as scary as giving a speech with real people, you know the virtual people aren't thinking negatively about you." As the current VRE utilized an audience with neutral facial expressions, the degree of engagement and realism may be increased if the facial expressions were negative or at least varied in emotion. In support of this hypothesis, research by Pertaub, Slater, & Barker (2002) comparing positive, neutral, and negative virtual audiences demonstrated that regardless of the participants' level of fear, all experienced more anxiety when giving a speech in front of the

negative audience. It also may be effective if the virtual audience is able to react to the participant's actions (e.g., hand movements, posture, vocal quality) and emotional state or if the participant was led to believe it was a real, live audience. The lack of intense immersion (or feelings of reality) is not necessarily limited to public speaking environments. Similar difficulties and need for increased realism may be encountered with other VREs as well. For example, when conducting exposure therapy using an airplane VRE for an individual with flight phobia, the patient knows they are not really in a plane that may crash. Researchers have attempted to increase the generalizability of VREs to real-life scenarios by including tactile stimuli, smells, or projecting images onto the real world environment.

Taken together, these findings suggest that VR is only partially able to satisfy Foa and Kozak's (1986) aforementioned basic requirements of emotional processing theory. However, while the VR environment is less immersive and less comparable to real-life circumstances than in vivo, it shares enough similarities with the participants' reported fear to elicit objective and subjective anxiety to have some use as a tool for conducting exposure therapy.

Although VR elicited a significant increase in physiological arousal, as predicted, VR elicited significantly less arousal and distress than the in vivo speech task whether assessed by subjective distress (SUDS ratings) or physiological response (HR, RSA, and SCR). Although the in vivo task elicited a higher change over baseline than the VR task for SCL, this difference was not significant, which may be reflective of the smaller sample size. This finding suggests that although VR appears to be effective in eliciting arousal, it is not able to serve as an equal replacement for an in vivo speech task. Therefore, the VR speech task may be better suited as an

intermediate step in an individuals' hierarchy and in particular for clinicians working in setting where conducting in vivo exposure is not feasible. The higher percentage of escape behavior during the in vivo speech task suggests that, in line with findings by Garcia-Palacios (2007), the VR speech task may be a useful first step for those who are initially unwilling to engage with in vivo exposures. Despite the drawbacks of the VR equipment (e.g., initial cost, ongoing maintenance, and specialized training in the operation of the equipment), it appears VR has the potential to alleviate the burden SAD places on the individual and clinicians.

Finally, the results did not support the third aim of the study regarding differences in physiological arousal between participants with SAD and controls. Against the predicted outcome, there were no significant differences between groups in terms of arousal. While this finding may be reflective of the widespread nature of public speaking fears amongst even healthy individuals, prior research by Slater (2006) was able to find significant differences in HR between Phobic and Confident Speakers. The lack of ability to find differences within the current study may be better accounted for by the opportunity for escape during the task or a ceiling effect as a result of using change scores. Furthermore, the majority of participants with SAD were not from a treatment seeking population and did not all report public speaking as their primary fear.

When comparing the current sample of participants with SAD to the treatment-seeking community sample in a study by Beidel et al (2010), the participants in the current study reported a lower average SUDS rating at baseline (M=1.16, SD=1.07 vs. M=3.20, SD=1.80, respectively) and following the in vivo speech task (M=6.79, SD=1.18 vs. M=7.00, SD=1.60, respectively).

In addition, participants with SAD in the current study reported a lower average SPAI score than the mean SPAI score of those from the treatment-seeking sample (*M*=97.66 vs. *M*=109.0, respectively). Controls in the current study were similar to those in the referenced study in terms of reported SUDS following the in vivo speech task (*M*=3.76, *SD*=0.65 vs. *M*=3.80, *SD*=1.80) but had a lower baseline SUDS rating (*M*=.40, *SD*=0.9 vs. *M*=1.70, *SD*=0.90) and equivalent SPAI scores (*M*=25.51 vs. *M*=23.80). Participants with SAD from the referenced study spoke somewhat longer than those with SAD in the current study (*M*=4.0 minutes vs. *M*=2.53 minutes, respectively). In addition, Controls from the referenced study spoke longer than controls in the current study (*M*=6.30 minutes vs. *M*=4.06 minutes, respectively). Although the participants with SAD in the current study appear less severe, based on length of time till escape during the in vivo speech tasks it would appear that participants in the current study were more distressed but this may be more reflective of the participants perceived ability to escape the task. Therefore, differences between groups may have been more pronounced if a treatment-seeking sample were used.

Limitations and Directions for Future Research

This study was not without its limitations. The primary limitation was the lack of a treatment-seeking sample. Thus, although the participants reported fear and distress in the setting, their concerns were not so disabling that it caused them to seek treatment. Future research may benefit from the inclusion of a treatment-seeking sample. Second, although physiological measurements are considered to be objective measures of arousal, they can be influenced by many factors. For example, changes in HR are found to occur just by the act of

speaking (Tardy, Thompson, & Allen, 1989), in addition the greater freedom of movement during the in vivo speech task may also have influenced HR. Factors such as posture, age, and general activity level may influence RSA (Berntson, 2007). In addition, several participants with improperly corrected vision reported difficulty in viewing the VR environment through the HMD visor and others found the visor uncomfortable and distracting. Therefore, future research may benefit from determining what is the minimal amount of equipment needed (e.g., would projecting the environment on a computer or projector screen be enough to elicit a response). Modifications such as those may allow for a greater ease of dissemination within the community. In addition, as the current study focused on the process of physiological arousal, it may also be of interest to examine differences in deceleration of arousal following the tasks to determine how quickly the participants are able to return to baseline levels of functioning.

In summary, this is the first investigation within the field of clinical psychology to use multiple measures of physiology to examine physiological arousal elicited by a VR and a comparable in vivo speech task. Based upon the results of this study, the VR speech task environment elicited a significant degree of physiological arousal but not to a degree comparable with an in vivo speech task. Overall, these findings were consistent with previously mentioned research and expand upon their findings. Therefore, VR speech tasks may be effective as an intermediate step on a hierarchy, a way to encourage those who are hesitant to engaging with in vivo exposure, or a substitute when it is not possible to conduct an in vivo speech task but it does not appear to be a replacement for confronting an individual's actual reported fear.

APPENDIX A: IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Maryann Owens and Deborah Casamassa Beidel**

Date: **June 15, 2012**

Dear Researcher:

On June 15, 2012, the IRB approved the following modifications until 03/08/2013 inclusive:

Type of Review:	IRB Addendum and Modification Request Form
Modification Type:	Addition of post participation document
Project Title:	Physiological Arousal in Adults with Social Phobia
Investigator:	Maryann Owens
IRB Number:	SBE-11-07928
Funding Agency:	None

The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 03/08/2013, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

IRB Coordinator

APPENDIX B: VIRTUAL CONFERENCE ROOM ENVIRONMENT

APPENDIX C: SUPPLEMENTARY FIGURES

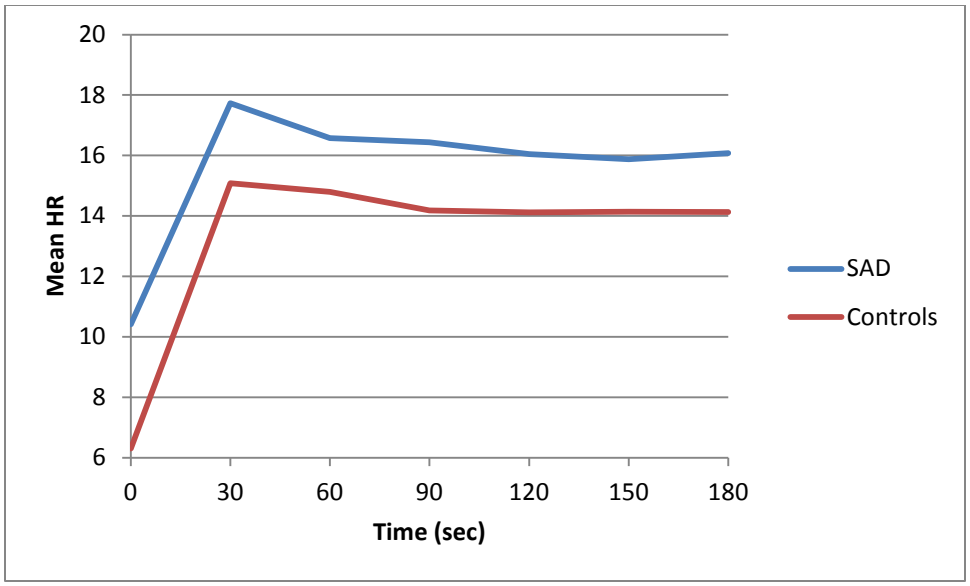

Figure 3 Changes in mean skin conductance level during the in vivo speech task.

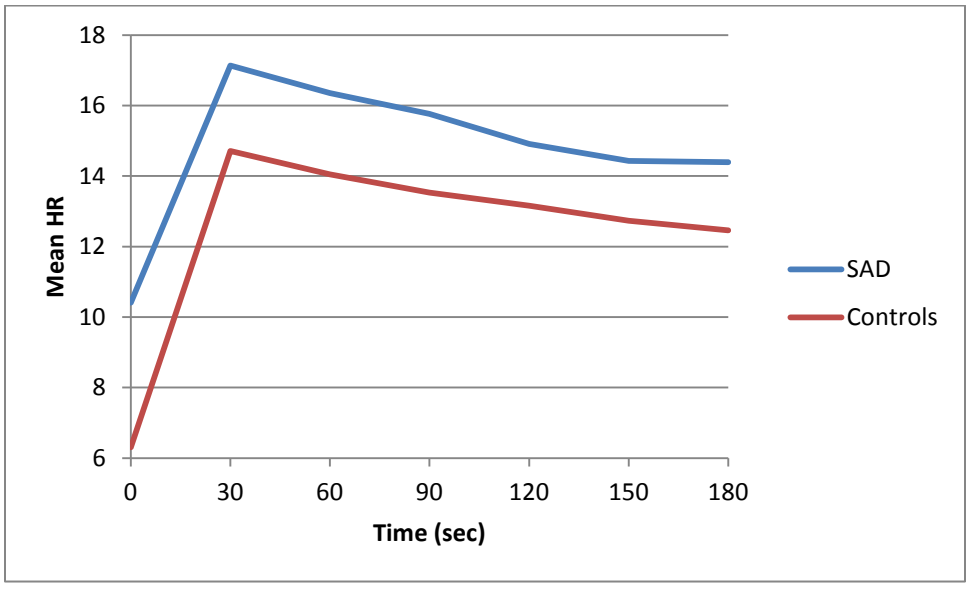

Figure 4 Changes in mean skin conductance level during the VR speech task.

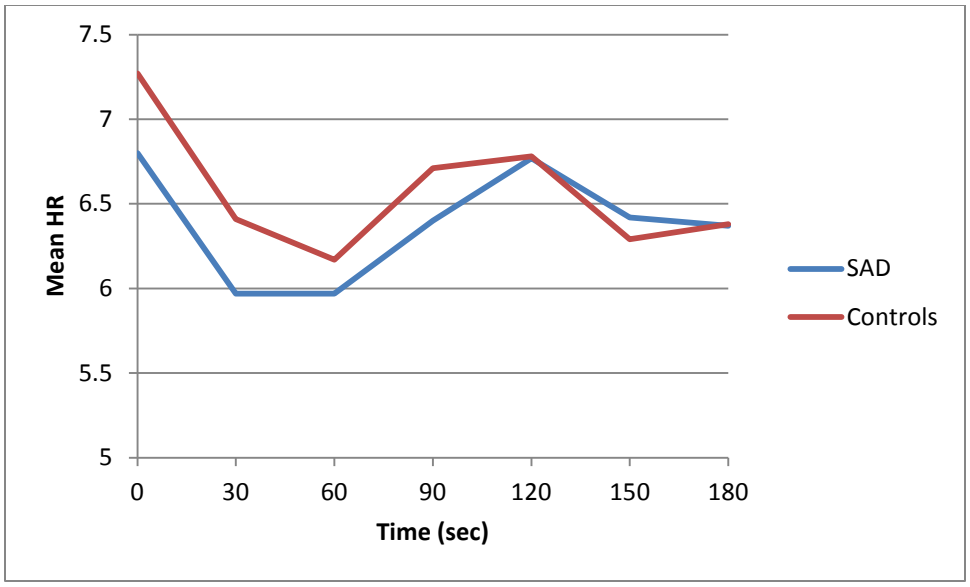

Figure 5 Changes in mean respiratory sinus arrhythmia during the in vivo speech task.

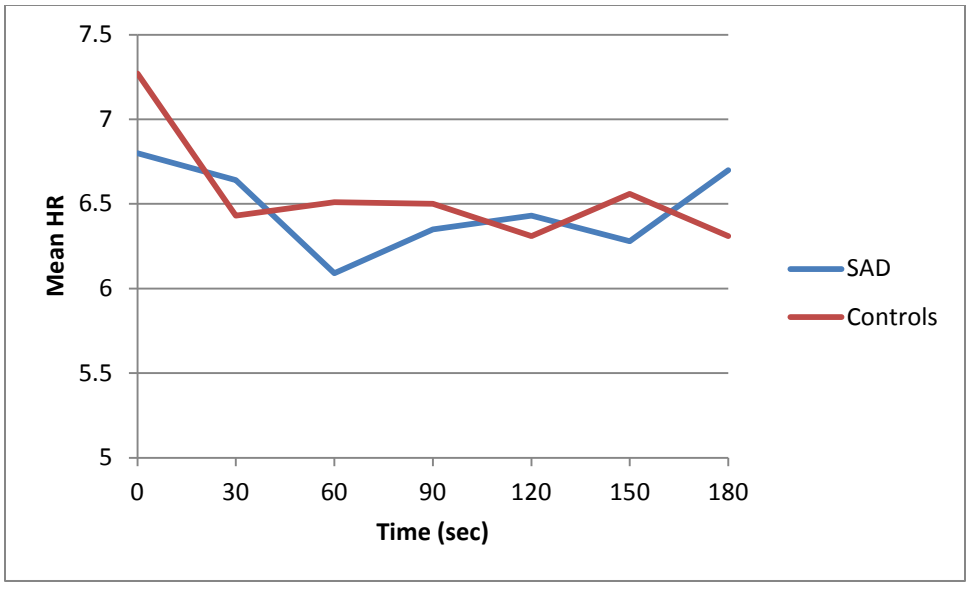

Figure 6 Changes in respiratory sinus arrhythmia during the VR speech task.

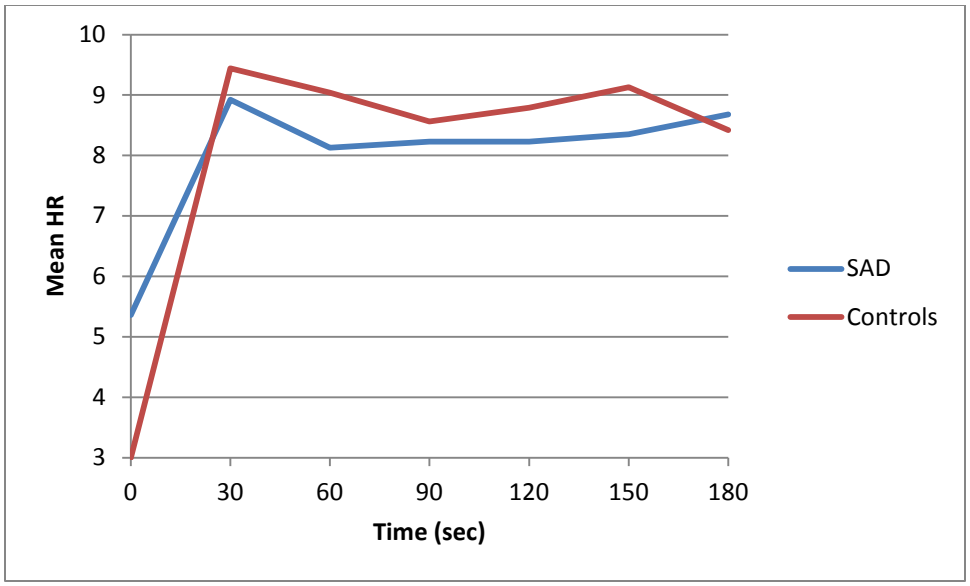

Figure 7 Changes in mean skin conductance response during the in vivo speech task.

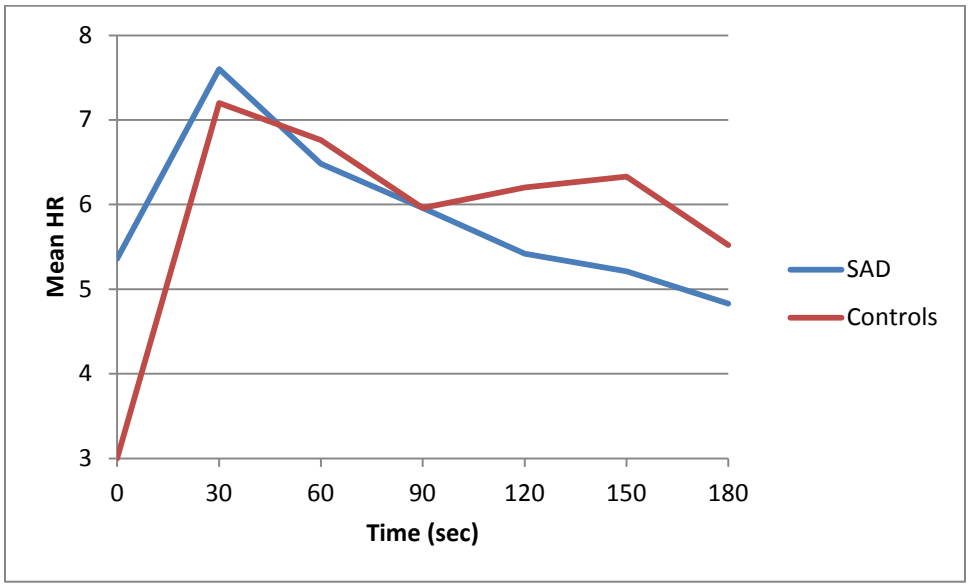

Figure 8 Changes in mean skin conductance response during the VR speech task.

LIST OF REFERENCES

Anderson, P., Rothbaum, B. O., & Hodges, L. F. (2003). Virtual reality exposure in the treatment of social anxiety. *Cognitive and Behavioral Practice, 10*(3), 240-247.

Anderson, P. L., Zimand, E., Hodges, L. F., & Rothbaum, B. O. (2005). Cognitive behavioral therapy for public-speaking anxiety using virtual reality for exposure. *Depression and Anxiety, 22*(3), 156-158.

American Psychiatric Association. Task Force on DSM-5. (2013). *Diagnostic and statistical manual of mental disorders : DSM-5* (5th ed.). Washington, DC: American Psychiatric Association.

Amies, P. L., Gelder, M. G., & Shaw, P. M. (1983). Social Phobia: A comparative clinical study. *Br J Psychiatry, 142*, 174-179.

Beidel, D. C., Borden, J. W., Turner, S. M., & Jacob, R. G. (1989). The Social Phobia and Anxiety Inventory: Concurrent validity with a clinic sample. *Behav Res Ther, 27*(5), 573-576. doi: 0005-7967(89)90093-4 [pii]

Beidel, D. C., Rao, P. A., Scharfstein, L., Wong, N., & Alfano, C. A. (2010). Social skills and social phobia: An investigation of DSM-IV subtypes. *Behav Res Ther, 48*(10), 992-1001. doi: S0005-7967(10)00131-2 [pii]10.1016/j.brat.2010.06.005

Beidel, D. C., Turner, S. M., Jacob, R. G., & Cooley, M. R. (1989). Assessment of social phobia: Reliability of an impromptu speech task. J*ournal of Anxiety Disorders,, 3,* 149-158.

Beidel, D. C., Turner, S. M., & Morris, T. L. (1999). Psychopathology of childhood social phobia. J *Am Acad Child Adolesc Psychiatry, 38(*6), 643-650. doi: S0890-8567(09)63173-7 [pii]10.1097/00004583-199906000-00010

Berntson, G. G., Quigley, K. S., & Lozano, D. A. V. E. (2007). Cardiovascular psychophysiology. *Handbook of psychophysiology*, *3*.

Botella, C., Banos, R., Gullen, V., Perpina, C., Aleaniz, M., & Pons, A. (2000). Telepsychology: Public speaking fear treatment on the internet. C*yberpsychology and Behavior, 3,* 959-968.

Brown, T. A., DiNardo, P., & Barlow, D. H. (1994). *Anxiety Disorders Interview Schedule Adult Version (Adis-IV: Client Interview Schedule)*. Oxford University Press, USA.

Brown, T. A., Di Nardo, P. A., Lehman, C. L., & Campbell, L. A. (2001). Reliability of DSM-IV anxiety and mood disorders: Implications for the classification of emotional disorders. J *Abnorm Psychol, 110(1*), 49-58.

Chambless, D. L., Foa, E. B., Groves, G. A., & Goldstein, A. J. (1979). Flooding with Brevital in the treatment of agoraphobia: Countereffective? Be*hav Res Ther, 17(3*), 243-251. doi: 0005-7967(79)90039-1 [pii]

Davidson, J. R. T., Potts, N. L. S., Richichi, E. A., Ford, S. M., Krishnan, K. R. R., Smith, R. D., & Wilson, W. (1991). The Brief Social Phobia Scale. *Journal of Clinical Psychiatry, 52,* 48-51.

Emmelkamp, P. M., & Kuipers, A. C. (1979). Agoraphobia: A follow-up study four years after treatment. *Br J Psychiatry, 134,* 352-355.

Foa, E. B., Grayson, J. B., Steketee, G. S., Doppelt, H. G., Turner, R. M., & Latimer, P. R. (1983). Success and failure in the behavioral treatment of obsessive-compulsives. *J Consult Clin Psychol, 51(2*), 287-297.

Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychol Bull, 99(1*), 20-35.

Fyer, A. J., Liebowitz, M. R., Gorman, J. M., Campeas, R., Levin, A., Davies, S. O., . . . Klein, D. F. (1987). Discontinuation of alprazolam treatment in panic patients. *Am J Psychiatry, 144(3*), 303-308.

Garcia-Palacios, A., Botella, C., Hoffman, H., & Fabregat, S. (2007). Comparing acceptance and refusal rates of virtual reality exposure vs. in vivo exposure by patients with specific phobias. *Cyberpsychology & Behavior*, *10*(5), 722-724.

Gould, R. A., Buckminster, S., Pollack, M. H., Otto, M. W., & Yap, L. (1997). Cognitive-Behavioral and Pharmacological Treatment for social phobia: A Meta-Analysis. *Cln Psychol Sci Prac, 4(4*), 291-306. doi: 10.1111/j.1468-2850.1997.tb00123.x

Greenberg, P. E., Sisitsky, T., Kessler, R. C., Finkelstein, S. N., Berndt, E. R., Davidson, J. R., . . . Fyer, A. J. (1999). The economic burden of anxiety disorders in the 1990s. J *Clin Psychiatry, 60(7*), 427-435.

Hamilton, M. (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery, and Psychiatry*, *23*(1), 56.

Harris, S. R., Kemmerling, R. L., & North, M. M. (2002). Brief virtual reality therapy for public speaking anxiety. *Cyberpsychology & Behavior*, *5*(6), 543-550.

Heimberg, R. G., Horner, K. J., Juster, H. R., Safren, S. A., Brown, E. J., Schneier, F. R., & Liebowitz, M. R. (1999). Psychometric properties of the Liebowitz Social Anxiety Scale. P*sychological Medicine, 29,* 199-212.

Hodges, L., Rothbaum, B. O., Kooper, R., Opdyke, D., Meyer, T., de Graff, J. J., & Williford, J. S. (1994). Presence as the defining factor in a VR Application: Georgia Institute of Technology.

Hofmann, S. G., & DiBartolo, P., M. (2000). An instrument to assess self-statements during public speaking: Scale development and preliminary psychometric properties. *Behav Ther, 31,* 499-515.

Katzelnick, D. J., Kobak, K. A., DeLeire, T., Henk, H. J., Greist, J. H., Davidson, J. R., . . . Helstad, C. P. (2001). Impact of generalized social anxiety disorder in managed care. *Am J Psychiatry, 158(1*2), 1999-2007.

Katzelnick, D. J., Kobak, K. A., Greist, J. H., Jefferson, J. W., Mantle, J. M., & Serlin, R. C. (1995). Sertraline for social phobia: A double-blind, placebo-controlled crossover study. Am *J Psychiatry, 152(9*), 1368-1371.

Kessler, R., Chiu, W., Demler, O., & Walters, E. (2005). Prevalence, Severity, and Comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62,* 617-627.

Kessler, R. C., Stang, P., Wittchen, H. U., Stein, M., & Walters, E. E. (1999). Lifetime comorbidities between social phobia and mood disorders in the US National Comorbidity Survey. *Psychological Medicine, 29,* 555-567.

Klinger, E., Bouchard, S., Légeron, P., Roy, S., Lauer, F., Chemin, I., & Nugues, P. (2005). Virtual reality therapy versus cognitive behavior therapy for social phobia: a preliminary controlled study. *Cyberpsychol Behav, 8(1*), 76-88. doi: 10.1089/cpb.2005.8.76

Kotlyar, M., Donahue, C., Thuras, P., Kushner, M. G., O'Gorman, N., Smith, E. A., & Adson, D. E. (2008). Physiological response to a speech stressor presented in a virtual reality environment. *Psychophysiology*, *45*(6), 1034-1037.

Krijn, M., Emmelkamp, P., Olafsson, R. P., & Biemond, R. (2004). Virtual reality exposure therapy of anxiety disorders: A review. *Clinical Psychology Review, 24(3*), 259-281.

Lee, J. M., Ku, J. H., Jang, D. P., Kim, D. H., Choi, Y. H., Kim, I. Y., & Kim, S. I. (2002). Virtual reality system for treatment of the fear of public speaking using image-based rendering and moving pictures. Cy*berpsychology and Behavior, 5*, 191-195.

Lee, K. M. (2004). Presence, explicated. Co*mmunication Theory, 14(1*), 27-50.

Liebowitz, M. R. (1987). Social phobia. *Modern Problems of Pharmacopsychiatry, 22*, 141-173.

Liebowitz, M. R., Gorman, J. M., Fyer, A. J., & Klein, D. F. (1985). Social phobia: Review of a neglected anxiety disorder. *Arch Gen Psychiatry, 42(7*), 729-736.

Mannuzza, S., Schneier, F. R., Chapman, T. F., Liebowitz, M. R., Klein, D. F., & Fyer, A. J. (1995). Generalized social phobia: Reliability and validity. *Arch Gen Psychiatry, 52(3*), 230-237.

Marks, I. M., & Gelder, M. G. (1966). Different ages of onset in varieties of phobia. *Am J Psychiatry, 123(2*), 218-221.

Marks, I. M., Hodgson, R., & Rachman, S. (1975). Treatment of chronic obsessive-compulsive neurosis by in-vivo exposure. A two-year follow-up and issues in treatment. *Br J Psychiatry, 127,* 349-364.

Marks, I. M., Swinson, R. P., Başoğlu, M., Kuch, K., Noshirvani, H., O'Sullivan, G., . . . Sengun, S. (1993). Alprazolam and exposure alone and combined in panic disorder with agoraphobia. A controlled study in London and Toronto. *Br J Psychiatry, 162,* 776-787.

North, M., North, S., & Coble, J. (1997). Virtual reality therapy: An effective treatment for the fear of public speaking. *International Journal of Virtual Reality, 3,* 2-7.

North, M. M., North, S. M., & Coble, J. R. (1996a). Effectiveness of virtual environment desensitization in the treatment of agoraphobia. *Presence: Teleoperators and Virtual Environments, 5,* 346-352.

North, M. M., North, S. M., & Coble, J. R. (1996b). Effectiveness of VRT for acrophobia Vi*rtual reality therapy: An innovative paradigm (*pp. 68-70). Colorado Springs: IPI Press.

North, M. M., North, S. M., & Coble, J. R. (1996c). Virtual reality therapy: An innovative paradigm VRT in the treatment of agoraphobia *(*pp. 46): IPI Press.

North, M. M., North, S. M., & Coble, J. R. (1998). Virtual reality therapy: an effective treatment for phobias. *Stud Health Technol Inform, 58,* 112-119.

Olfson, M., Guardino, M., Struening, E., Schneier, F. R., Hellman, F., & Klein, D. F. (2000). Barriers to the treatment of social anxiety. *Am J Psychiatry, 157(4*), 521-527.

Patel, A., Knapp, M., Henderson, J., & Baldwin, D. (2002). The economic consequences of social phobia. *J Affect Disord, 68(2*-3), 221-233. doi: S0165032700003232 [pii]

Pertaub, D. P., Slater, M., & Barker, C. (2002). An experiment of public speaking anxiety in response to three different types of virtual audience. *Presence: Teleoperators and Virtual Environments, 11,* 68-78.

Powers, M. B., & Emmelkamp, P. M. (2008). Virtual reality exposure therapy for anxiety disorders: A meta-analysis. *J Anxiety Disord,* 22(3), 561-569. doi: S0887-6185(07)00103-X [pii] 10.1016/j.janxdis.2007.04.006

Regenbrecht, H. T., Schubert, T. W., & Friedman, F. (1998). Measuring the sense of presence and its relation to fear of heights in virtual environments. *International Journal of Human-Computer Interaction, 10,* 233-249.

Robins, L. N., & Regier, D. A. (1991). *Psychiatric disorders in America: The epidemiologic catchment area study:* Free Press.

Rothbaum, B. O., & Hodges, L. F. (1999). The use of virtual reality exposure in the treatment of anxiety disorders. *Behavior Modification, 23(4*), 507.

Schneier, F. R., ohnson, J., Hornig, C. D., Liebowitz, M. R., & Weissman, M. M. (1992). Social Phobia: Comorbidity and morbidity in an epidemiologic sample. *Archives of General Psychiatry, 49,* 282-288.

Schubert, T., Friedmann, F., & Regenbrecht, H. (2001). The experience of presence: Factor analytic insights. *Presence: Teleoperators and Virtual Environments, 10,* 266-281.

Schuemie, M. J., Bruynzeel, M., Drost, L., Brinckman, M., de Haan, G., Emmelkamp, P. M. G., & van der Mast, C. A. P. G. (2000). *Treatment of acrophobia in virtual reality: A pilot study.* Paper presented at the euromedia, Antwerp, Belgium.

Slater, M., Pertaub, D., & Steed, A. (1999). Public Speaking in Virtual Reality: Facing an Audience of Avatars. *IEEE Computer Graphics and Applications, 19*, 6-9.

Slater, M., Pertaub, D. P., Barker, C., & Clark, D. M. (2006). An experimental study on fear of public speaking using a virtual environment. *Cyberpsychol Behav, 9(5*), 627-633. doi: 10.1089/cpb.2006.9.627

Stein, M. B., Walker, J. R., & Forde, D. R. (1996). Public-speaking fears in a community sample. Prevalence, impact on functioning, and diagnostic classification. *Arch Gen Psychiatry, 53(2*), 169-174.

Tardy, C. H., Thompson, W. R., & Allen, M. T. (1989). Cardiovascular Responses during Speech: Does Social Support Mediate the Effects of Talking on Blood Pressure? *Journal of Language and Social Psychology*, 8(3-4), 271-285.

Taylor, S. (1996). Meta-analysis of cognitive-behavioral treatments for social phobia. J *Behav Ther Exp Psychiatry, 27(1*), 1-9. doi: 0005791695000585 [pii]

Turner, S. M., Beidel, D. C., Dancu, C. V., & Keys, D. J. (1986). Psychopathology of social phobia and comparison to avoidant personality disorder. *J Abnorm Psychol, 95(4*), 389-394.

Turner, S. M., Beidel, D. C., Dancu, C. V., & Stanley, M. A. (1989). An empirically derived inventory to measure social fears and anxiety: The Social Phobia and Anxiety Inventory. *Psychological Assessment: A Journal of Consulting and Clinical Psychology, 1*, 35-40.

van Vliet, I. M., den Boer, J. A., & Westenberg, H. G. (1994). Psychopharmacological treatment of social phobia; a double blind placebo controlled study with fluvoxamine. *Psychopharmacology (Berl), 115(1*-2), 128-134.

Weiller, E., Bisserbe, J. C., Boyer, P., Lepine, J. P., & Lecrubier, Y. (1996). Social phobia in general health care: An unrecognised undertreated disabling disorder. *Br J Psychiatry, 168(2*), 169-174.

Wiederhold, B., & Wiederhold, M. (1998). A review of virtual reality as a psychotherapeutic tool. *CyberPsychology & Behavior, 1,* 45-52.

Wittchen, H. U., & Beloch, E. (1996). The impact of social phobia on quality of life. *Int Clin Psychopharmacol, 11 Suppl 3,* 15-23.

Wittchen, H. U., Stein, M. B., & Kessler, R. C. (1999). Social fears and social phobia in a community sample of adolescents and young adults: Prevalence, risk factors and co-morbidity. *Psychol Med, 29(2*), 309-323.

Zhang, W., Ross, J., & Davidson, J. R. (2004). Social anxiety disorder in callers to the Anxiety Disorders Association of America. *Depress Anxiety, 20(3*), 101-106. doi: 10.1002/da.20020